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WaveNet: A Web-Based Metocean Data Access, Processing and Analysis Tool; Part 4 – GLOS/GLCFS Database

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PURPOSE: This Coastal and Hydraulics Engineering Technical Note (CHETN) describes coupling of the Great Lakes Coastal Forecasting System (GLCFS) database to WaveNet, the first module of MetOcnDat (Meteorological and Oceanographic Data or Metocean data) management and analysis system. This Part 4 in the WaveNet technical note series provides a step-by-step procedure for users to access, process, and analyze wave and wind data from the GLCFS database, which is part of the Great Lakes Observing System (GLOS) data portal.

BACKGROUND: WaveNet is a web-based, Graphical-User-Interface (GUI) data management tool developed for Corps coastal modeling and planning missions that require metocean data (e.g., winds, waves, tides, water levels). WaveNet allows users to access, process, and analyze wave and wind data from different data sources and provides a combination of analysis and graphical tools to minimize the complexity and uncertainty of data processing in project applications. It allows users to check status of data processing, availability of data, and quality and consistency of data. Users can extract, download, analyze, and prepare input files for numerical wave models and obtain tabular and graphical information for project planning and reporting and further analysis. Wilson et al. (2012), and Demirbilek et al. (2013, 2014) provided a description of WaveNet in three companion CHETNs and demonstrated the utility of WaveNet for wave databases from the National Data Buoy Center (NDBC), Wave Information Study (WIS), and Coastal Data Information Program (CDIP). This User's Guide includes step-by-step instructions for accessing the GLOS/GLCFS database via WaveNet and one example application that illustrates processing and analysis of data for project planning, design, and evaluation studies, and generation of input files for numerical wave models.

WaveNet employs a Google Map® interface to query, select, and display data for a given geographic region from different sources available. Users select the date range to query the availability of data; plot, analyze, and extract data; post-process to produce tabular data and plots in a desired format; and write input files for numerical models. WaveNet helps users to obtain statistical wave parameters such as significant wave height, peak period, and direction and to generate wave and wind roses and histograms of directional wave data for project needs. Types of outputs available in WaveNet are image files (*.png), portable document files (*.pdf), Matlab figures (*.fig), text files (*.csv or *.txt), and spectral input files (*.eng) for numerical models. Users can modify the figures to view data plots and change axes and labels or text for project reports and other publications as necessary. The *.eng is an input file in the format required by numerical wave models CMS-Wave (Demirbilek and Rosati 2011; Lin et al. 2011a, b; Lin et al. 2008) and STWAVE (Massey et al. 2011).

The following example illustrates the use of WaveNet with GLOS/GLCFS database. This is done in a step-by-step manner and includes comments and instructions to guide users, where necessary.

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The National Oceanic and Atmospheric Administration (NOAA) Great Lakes Coastal Forecasting System is a numerical model that calculates waves, currents, and temperatures for each of the Great Lakes. The GLCFS Nowcast is run four times per day and provides estimates of conditions at the time the model was run while the GLCFS Forecast runs twice per day and provides a prediction of conditions 60 hours into the future. The model results provide 11 output variables, including significant wave height in meters, wave period in seconds, and wave direction in degrees, which are accessed and used by WaveNet. Users must be aware that the direction conventions used by the available wave data sites may vary. For example, GLCFS references wave directions *to* north while the WIS wave direction is *from* north. Additional information about GLOS/GLCFS is available from this website: http://glos.us/data-access/data-portal.

EXAMPLE: GLOS/GLCFS Data for Lake Michigan

Assume the following wave data are needed in Lake Michigan at 42.43N latitude, 87.14W longitude for a project: significant wave height, peak or mean wave period and mean direction in tabular form, wave roses for 1 June 2013 to 30 July 2013, and an *.eng file for CMS-Wave simulations. This example shows how to use WaveNet to access the GLOS/GLCFS database, fetch the data from the source, and prepare data in the required format in files for project documents and for use in a numerical wave model.

Step 1. Start WaveNet. Click the following link on an ACE-IT machine to start the WaveNet server: http://wavenet.usace.army.mil. Under data sources at upper right, select **GLOS/GLCFS**. Use the mouse and Google Map® to select Lake Michigan (Figure 1).

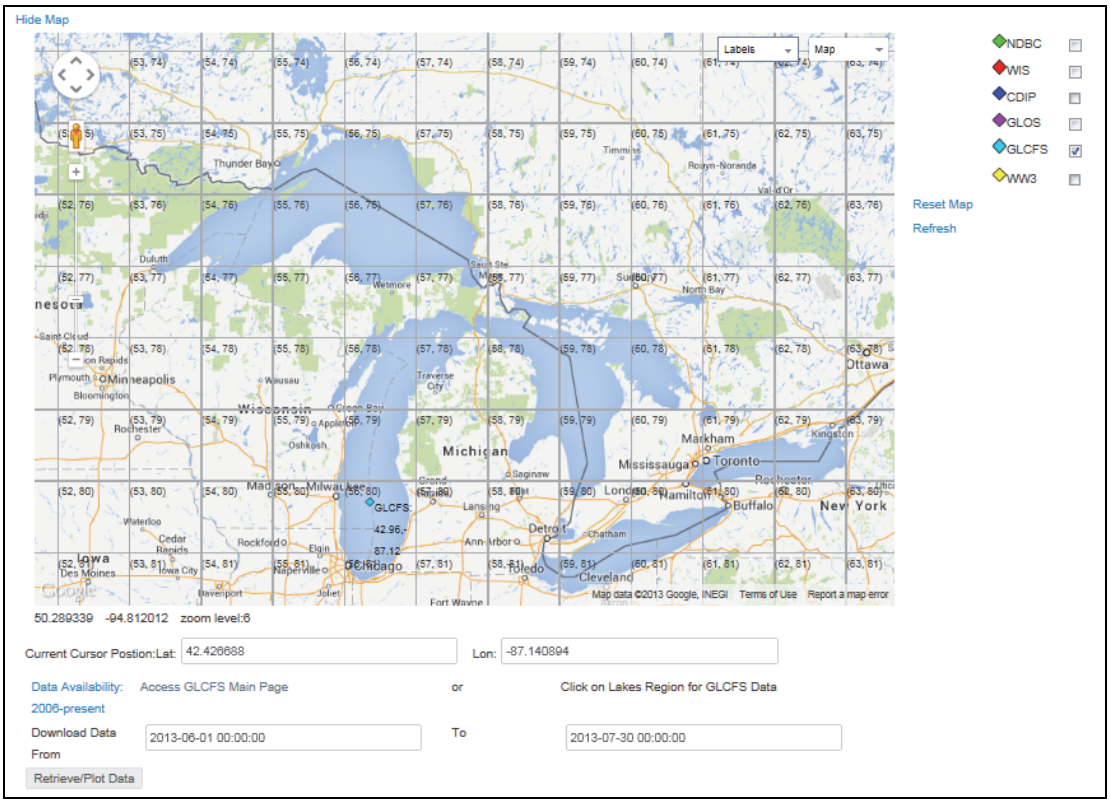

Figure 1. WaveNet main page for users to select the area of interest on Google Map®.

Step 2. Select a geographic point where data are needed. Zoom into the area of interest in Lake Michigan (Figure 2) to select the geographic location to access the point-specific data available from the GLOS/GLCFS database. This can be any point in the water body of Lake Michigan in Figure 2. Use the **Click on Lakes Region for GLCFS Data** located at the bottom of Figure 2; then click to a water point in the lake. The coordinates of point will be displayed. Specify the start date (1 Jun 2013) and the end date (30 Jul 2013); choose Metric or English for units; and click **Retrieve/Plot Data** located at the bottom of Figure 2. WaveNet will fetch the wave height, period, and direction time-series data from the data source for viewing and processing.

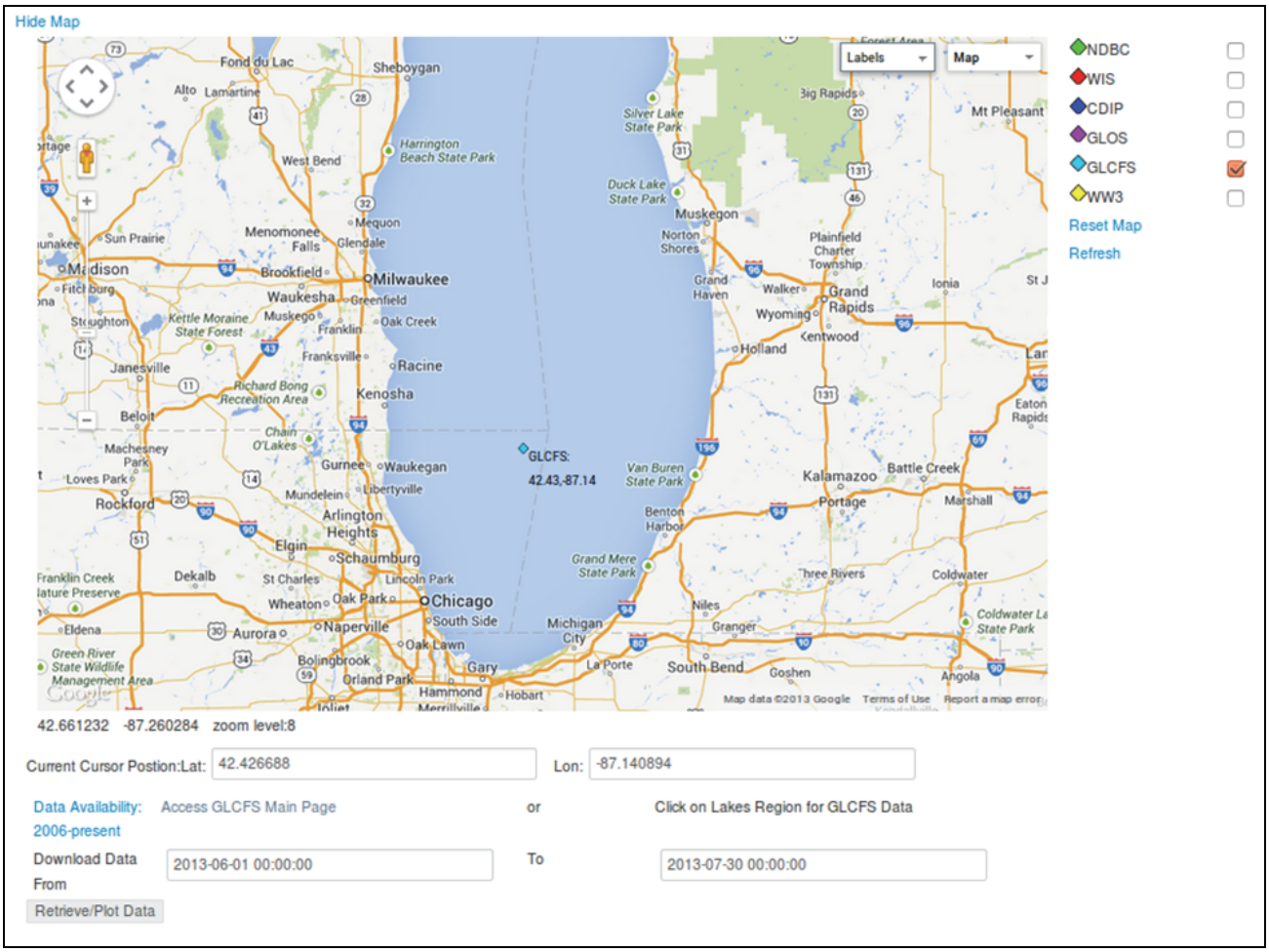

Figure 2. GLOS/GLCFS map zoomed in to Lake Michigan.

Alternatively, click on the **Access GLCFS Main Page** link at the bottom of Figure 2 to access the point query tool available from the GLFCS website: *http://glos.us/data-tools/point-query-tool-glcfs*. Figure 3 shows a completed data request form and types of data available. (Users can also download and process data this way using their own analysis programs, if so desired.)

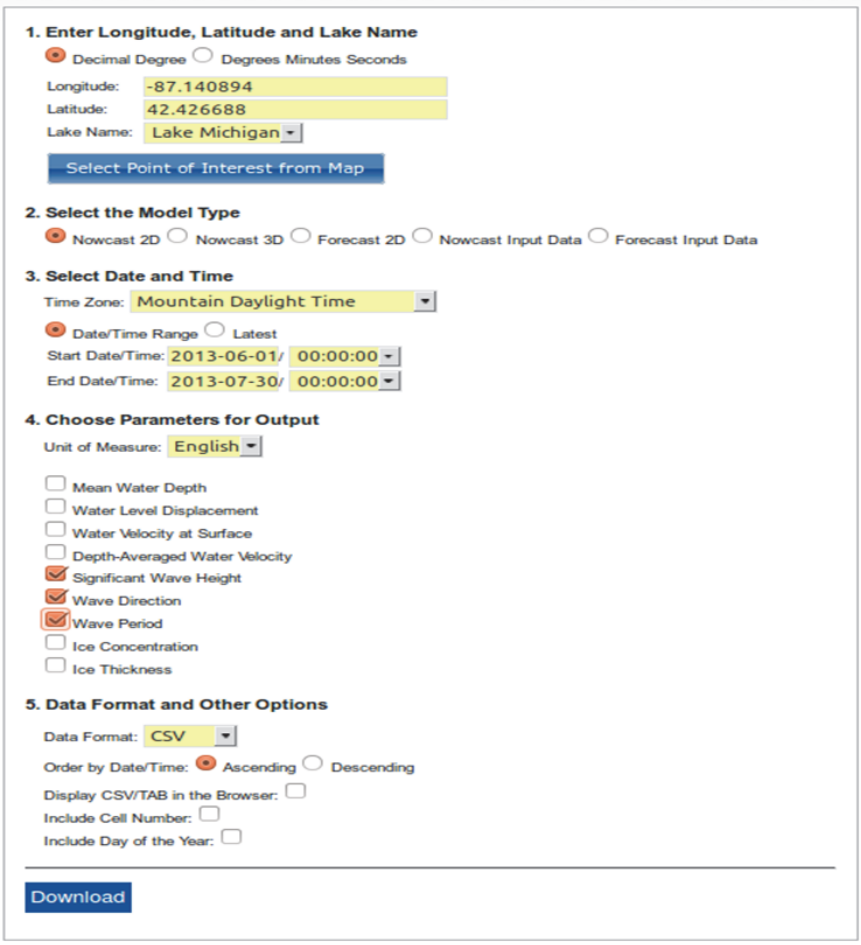

Figure 3. GLOS/GLCFS point query page.

Step 3. Access data display and view. The *slider bar* at the bottom of Figure 4 can be used for changing the start and end times. To narrow the time window of interest to specific days or months, use the slider bar at the bottom of the plot or click on the display box. Two options are available to change dates: type inside the start and end date boxes or use the calendar (Figure 4). Double click within the start and end time boxes to get the calendar. The timeline plot will show data availability for wave height, including the data gaps. To preview or download the selected Station data, plot wave data parameters either using the GLOS/GLCFS website data management tools or WaveNet's tools. Time series of the wave height is displayed for the user-specified time period. This display uses the WaveNet tools, which perform different tasks using custom-developed codes for each data source. This prevents potential errors in the data analyses. WaveNet contains custom analyses capabilities which may not be available from the data source's website.

Step 4. **Download data for project needs**. To perform additional analyses of data, click on **Tabular Data** to save data in a *.csv file (Figure 4). The *csv* is an ASCII spreadsheet with comma-separated values in text format. Table 1 displays the partially tabulated *.csv data saved by WaveNet. These ASCII data can be used with the Matlab, Fortran, Excel, or other software or commercial plotting packages, if desired.

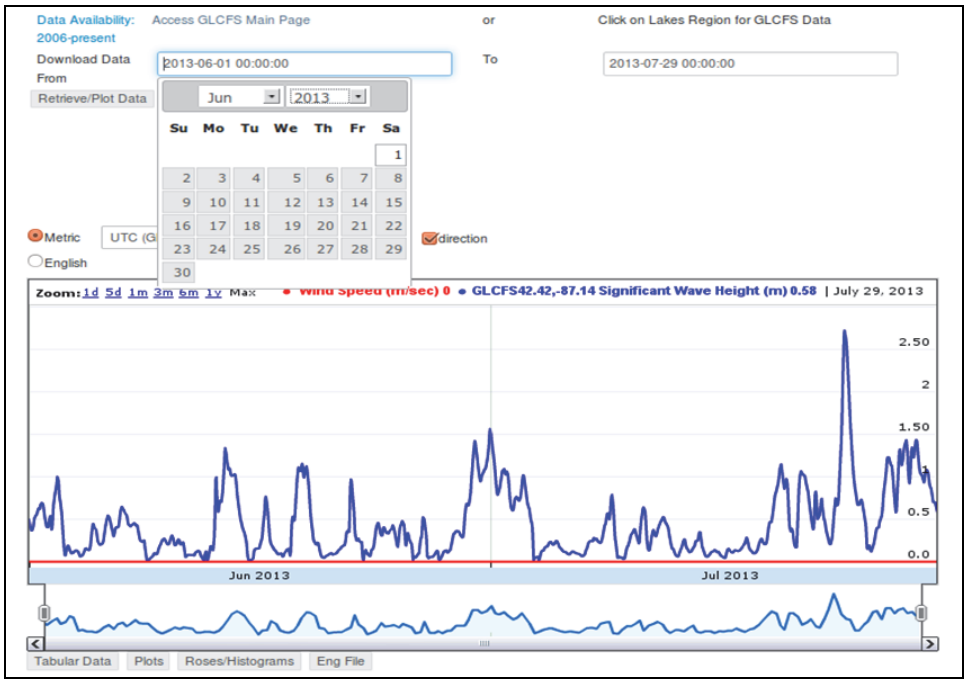

Figure 4. Time series of wave height for user-selected time window.

Table 1. Tabulated data downloaded to local machine.

	A	B	C	D	E	F	G	H
1	yyyy	mm	dd	hh	min	WaveHt	WavePer	WaveDir
2						m	sec	deg
3	2013	6	1	0	0	0.5	3.1	184
4	2013	6	1	1	0	0.45	3	182
5	2013	6	1	2	0	0.41	2.8	182
6	2013	6	1	3	0	0.37	2.6	181
7	2013	6	1	4	0	0.37	2.5	180
8	2013	6	1	5	0	0.37	2.5	179
9	2013	6	1	6	0	0.39	2.6	178
10	2013	6	1	7	0	0.42	2.7	178
11	2013	6	1	8	0	0.49	2.8	179
12	2013	6	1	9	0	0.52	3	182
13	2013	6	1	10	0	0.53	3	184
14	2013	6	1	11	0	0.55	3.1	187
15	2013	6	1	12	0	0.55	3.1	189
16	2013	6	1	13	0	0.56	3.1	190
17	2013	6	1	14	0	0.61	3.2	191
18	2013	6	1	15	0	0.63	3.3	192
19	2013	6	1	16	0	0.62	3.3	193
20	2013	6	1	17	0	0.63	3.3	193

Step 5. Generate wave roses and histograms. If the data source does not provide rose plots or histograms, these processing tools are available in WaveNet, and users can generate such plots for waves for the segment of downloaded data by clicking on **Roses/Histograms** below the timeline plot in Figure 4. The percent occurrence is depicted by radial circles, and 0.5 meter (m) wave height bands are color coded in the radial direction in Figure 5. The direction bins for waves approaching the shore are displayed in color.

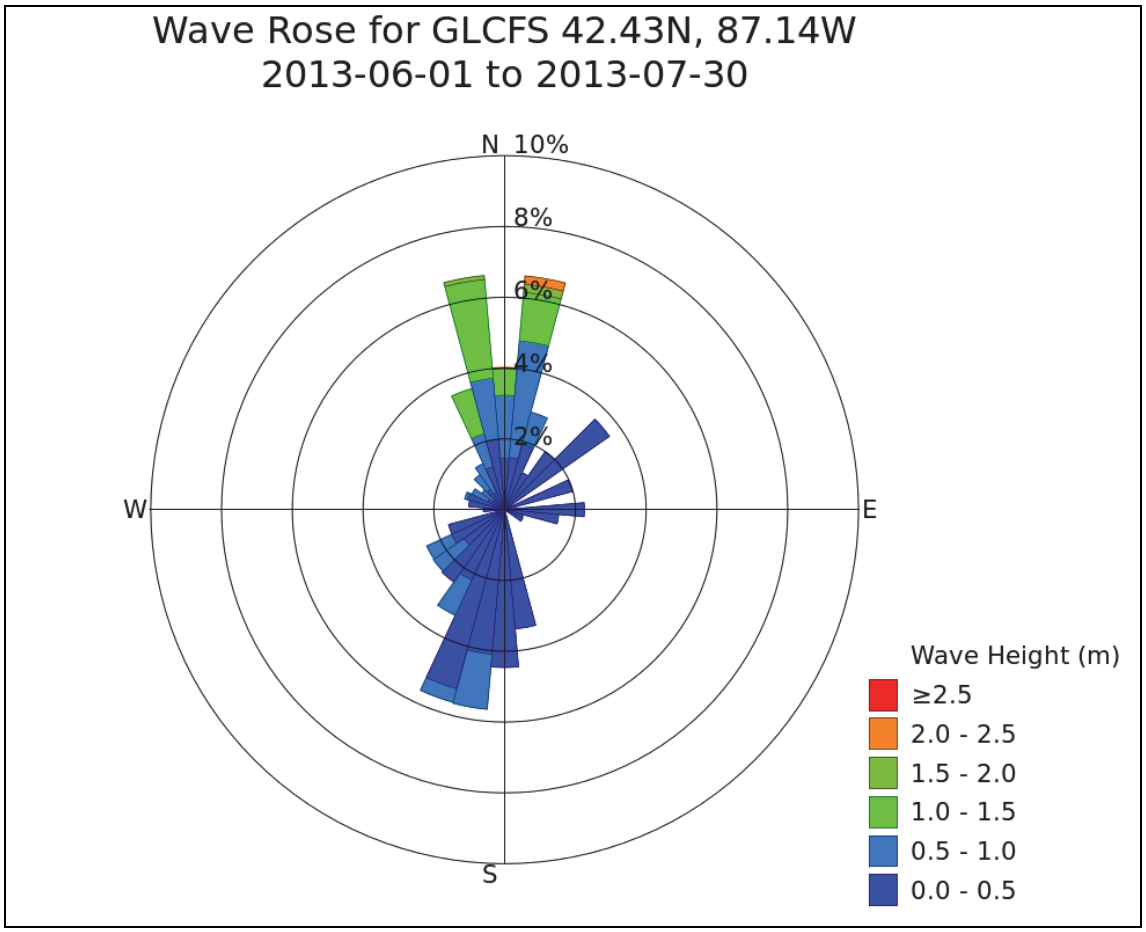

Figure 5. Rose plot of wave heights.

Figure 6 is a wave histogram that illustrates the statistical distribution of wave height. Wave height is less than 0.25 m for approximately 45% of population and less than 15% of waves have heights exceeding 1 m. There is no rose plot and histogram for wind speed, but if this location had wind data, another rose plot and histogram for the wind speed would also be generated.

Step 6. Perform desktop data analyses. After the segments of data have been accessed from the GLOS/GLCFS database and reviewed and downloaded to a local machine using WaveNet, then perform certain data analyses. For example, the CMS-Wave and STWAVE models require an *.eng file for directional wave input. If directional wave data (1D or 2D wave spectra and associated Fourier coefficients used to generate wave spectra) are available from the data source sites, download these files and perform post-processing analyses for project needs. If Fourier coefficients are not provided by the data sources, perform these operations using WaveNet. Click on **Eng File** located below the timeline plot in Figure 7. The *.eng files are listed at the bottom of Figure 7 according to the timeline selected. Table 2 displays the partial content of a sample *.eng file for illustration. For additional information about the *.eng file, see Lin et al. (2008, 2011a).

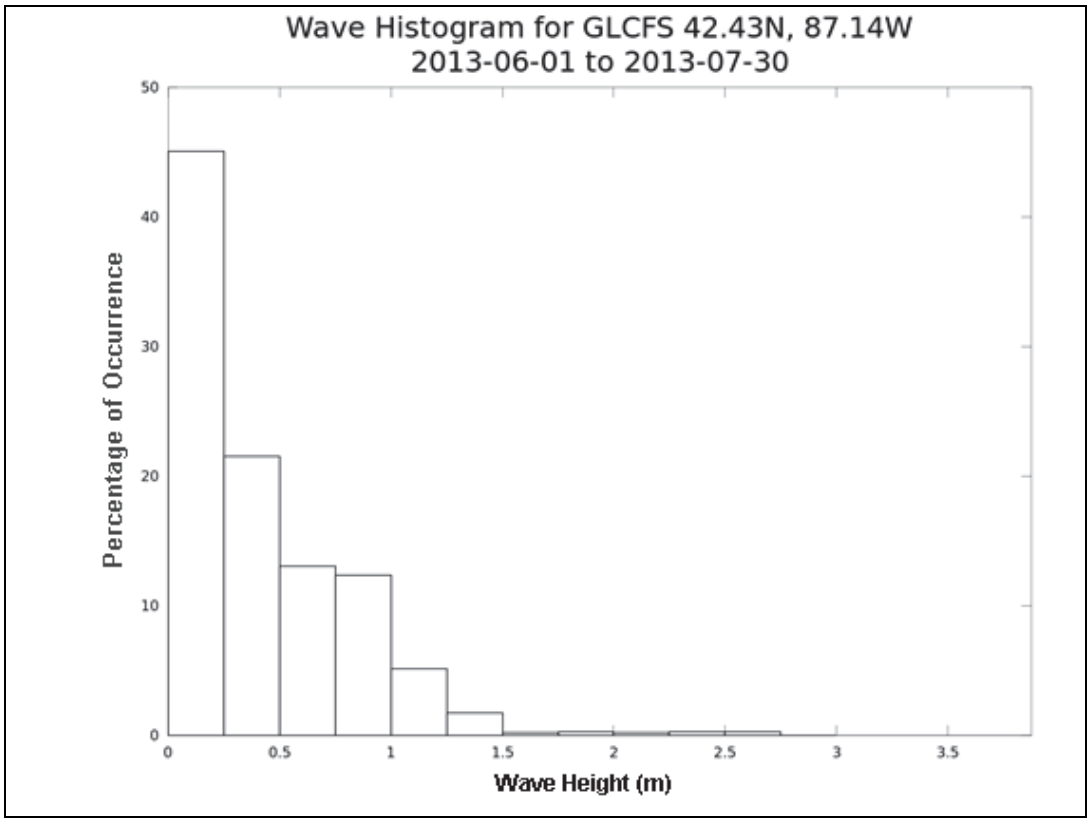

Figure 6. Histogram of wave heights.

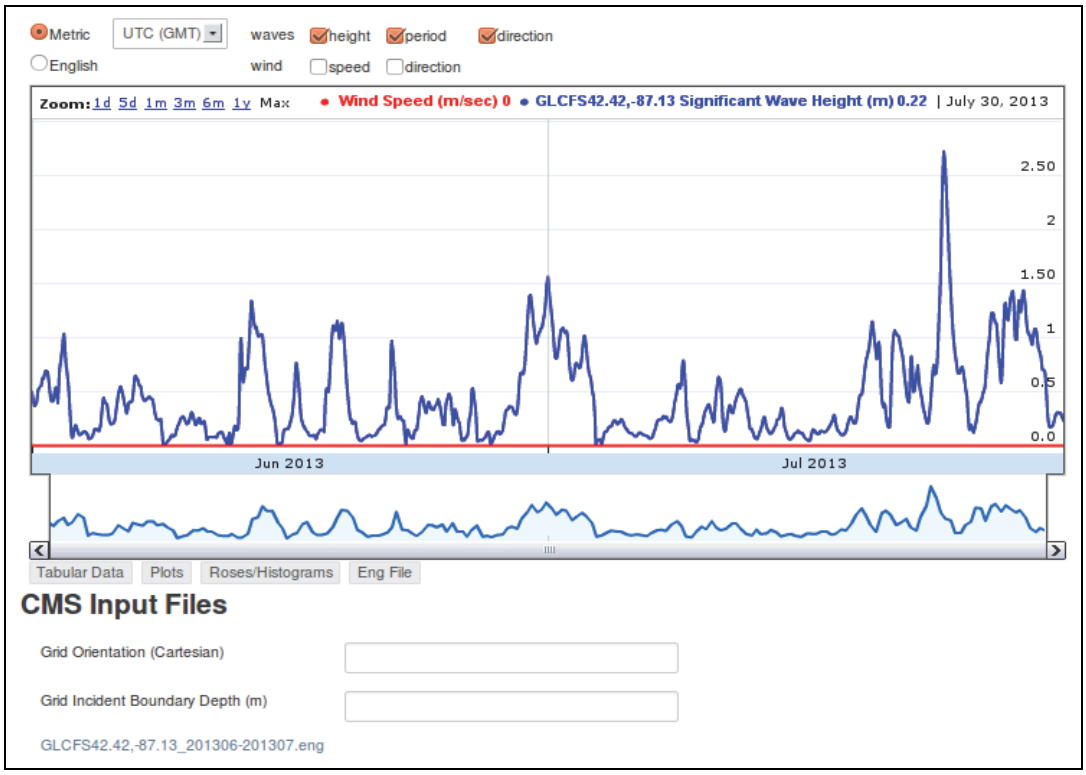

Figure 7. The *.eng input files generated by WaveNet.

Table 2. Partial content of an *.eng wave input file generated by WaveNet.

```
30 35
0.04000 0.05000 0.06000 0.07000 0.08000 0.09000 0.10000 0.11000 0.12000 0.13000
0.14000 0.15000 0.16000 0.17000 0.18000 0.19000 0.20000 0.21000 0.22000 0.23000
0.24000 0.25000 0.26000 0.27000 0.28000 0.29000 0.30000 0.31000 0.32000 0.33000
9040821     9.1        -42.    0.30000    0.00
   0.00032    0.00033    0.00034    0.00034    0.00033    0.00032
   0.00030    0.00029    0.00026    0.00024    0.00021    0.00018    0.00015
   0.00013    0.00010    0.00007    0.00005    0.00003    0.00001    0.00000
   0.00001    0.00005    0.00010    0.00017    0.00025    0.00033    0.00043
   0.00052    0.00062    0.00071    0.00081    0.00089    0.00097    0.00103
   0.00108    0.00112    0.00114    0.00115    0.00114    0.00112    0.00108
   0.00103    0.00097    0.00089    0.00081    0.00071    0.00062    0.00052
   0.00043    0.00033    0.00025    0.00017    0.00010    0.00005    0.00001
   0.00005    0.00017    0.00034    0.00056    0.00082    0.00111    0.00142
   0.00174    0.00206    0.00238    0.00268    0.00296    0.00322    0.00343
   0.00360    0.00373    0.00381    0.00384    0.00381    0.00373    0.00360
   0.00343    0.00322    0.00296    0.00268    0.00238    0.00206    0.00174
   0.00142    0.00111    0.00082    0.00056    0.00034    0.00017    0.00005
   0.00005    0.00017    0.00035    0.00057    0.00084    0.00113    0.00144
   0.00177    0.00210    0.00242    0.00273    0.00302    0.00328    0.00350
   0.00367    0.00380    0.00388    0.00391    0.00388    0.00380    0.00367
   0.00350    0.00328    0.00302    0.00273    0.00242    0.00210    0.00177
   0.00144    0.00113    0.00084    0.00057    0.00035    0.00017    0.00005
   0.00009    0.00031    0.00063    0.00103    0.00151    0.00204    0.00261
   0.00320    0.00380    0.00439    0.00495    0.00546    0.00593    0.00632
   0.00664    0.00688    0.00702    0.00707    0.00702    0.00688    0.00664
   0.00632    0.00593    0.00546    0.00495    0.00439    0.00380    0.00320
   0.00261    0.00204    0.00151    0.00103    0.00063    0.00031    0.00009
   0.00007    0.00025    0.00052    0.00086    0.00125    0.00169    0.00216
   0.00265    0.00315    0.00363    0.00409    0.00452    0.00491    0.00524
   0.00550    0.00570    0.00581    0.00585    0.00581    0.00570    0.00550
   0.00524    0.00491    0.00452    0.00409    0.00363    0.00315    0.00265
   0.00216    0.00169    0.00125    0.00086    0.00052    0.00025    0.00007
   0.00007    0.00026    0.00053    0.00087    0.00127    0.00171    0.00219
   0.00268    0.00318    0.00367    0.00414    0.00458    0.00497    0.00530
   0.00557    0.00576    0.00588    0.00592    0.00588    0.00576    0.00557
   0.00530    0.00497    0.00458    0.00414    0.00367    0.00318    0.00268
```

CONCLUSIONS: This CHETN describes the application of WaveNet to the GLOS/GLCFS database. An example is provided with a step-by-step procedure to demonstrate how to use WaveNet to access wave data from the GLCFS website. The same steps are also applicable to the GLOS data source to extract and analyze data for use in coastal navigation and storm damage reduction projects. This user guide for engineers and planners helps them to obtain wave data for project planning, design, and evaluation study reports and to develop input files required for numerical wave models. Note that GLOS/GLCFS data vary in content, complexity, and accuracy of information. The goal is to enhance the capabilities of WaveNet to help Districts obtain project-specific data from the GLOS/GLCFS and other data sources. User feedback is encouraged for expanding and improving the capabilities of WaveNet to better serve the USACE community. In development are a number of analysis capabilities for post-processing wave data downloaded by users with WaveNet. Descriptions and example applications of these analyses will be provided in the upcoming CHETNs in this series.

POINTS OF CONTACT: This CHETN was prepared as part of the Coastal Inlets Research Program (CIRP). The POC for technical inquiries is Zeki Demirbilek (*Zeki.Demirbilek@usace.army.mil*). For information about CIRP, please contact the CIRP Program Manager, Julie Dean Rosati (*Julie.D.Rosati@usace.army.mil*). This technical note should be referenced as follows:

Demirbilek, Z., L. Lin, and D. Wilson. 2014. *Wavenet: A web-based metocean data access, processing, and analysis tool; part 4–GLOS/GLCFS database.* ERDC/CHL CHETN-IV-99. Vicksburg, MS: U.S. Army Engineer Research and Development Center.

An electronic copy of this CHETN is available from http://chl.erdc.usace.army.mil/chetn.

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